SOME SUGGESTIONS FOR COURSES IN MATHEMATICS FOR NON-COLLEGE PREPARATORY STUDENTS.*

The question of college preparatory mathematics has been so long under discussion in all its aspects that it would appear that special attention is due the pupil who does not expect to go to college, and for whom the secondary institution is the finishing school. Valuable as are the standard courses in mathematics as given in most high schools, other material can unquestionably be substituted for at least a part of them which will be of more immediate practical use to the pupil who expects to take up his life work immediately after leaving the high or other secondary school. It is manifestly impossible to suggest courses which will be applicable to all schools, or even to all schools of a given type, due to widely varying local conditions as well as to great differences in the caliber and future prospects of the pupils. The committee has spent much time and thought upon the subject and finds it difficult to recommend a complete definite course for any school, preferring rather to offer suggestions which may be the means of inspiring our schools to improve present courses or to construct practical and useful ones for our boys and girls.

Realizing that the variety and scope of our schools is almost without limit, we shall confine our discussion to three comprehensive types, as follows: (A) The academic high school with no shops or other special mechanical equipment, (B) the high, trade, or vocational school with special mechanical equipment, and (C) the commercial school.

(A) The Academic High School with no Shops or other Special Mechanical Equipment.

This class includes the large majority of our high schools, ranging from the small school of the country town to the well

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established high grade institution of the city. From their ranks come a large percentage of the pupils who are preparing for college. Of those who are undecided, or who do not expect to go to college, some will make up their minds to continue in a higher institution after having taken one or two or three years in high school. The courses in mathematics should be so arranged that these pupils should lose no more time than is necessary in making the transition from one course to the other, although it certainly would not be wise judgment to require all pupils to take full college preparatory work simply because some expect to, and others possibly may go to college. A course which is of value to a person who does not expect to attend a college should also be of value to him who carries his studies into the higher institutions. The pupils should be helped to find themselves, and those who have little or no expectation of going to college should be given the material which will be of the greatest immediate practical value to them.

Nearly every intelligent and progressive man uses arithmetic in his work to a greater or less degree. The deplorable weakness of many of our high school graduates in the use of arithmetic calls forth abundant criticism of much of the mathematics which we require of our pupils. By all means the most important thing, mathematically speaking, for our boys and girls is a thorough grounding in the principles and practice of common arithmetic.

For pupils of this class the following is recommended:

Ninth and Tenth Years.—(*a*) Two years of elementary algebra and plane geometry, in common with the college preparatory group for boys and girls alike. The question of whether a year of algebra should be followed by a year of geometry or the reverse, or whether there should be a judicious dovetailing of one into the other, is not appropriate to this particular paper.

Eleventh and Twelfth Years.—(a) A review of arithmetic, particularly the four fundamental operations as applied to whole numbers, common and decimal fractions, percentage, square and cube root, with emphasis placed on mental calculations, accurate results and short methods.

(*b*) Use of the slide rule.

(*c*) Plane and solid mensuration, with a large number of practical problems based upon it.

(*d*) Simple mechanics of forces.

(*e*) Logarithms, their theory and practical use.

(*f*) A brief, practical course in trigonometry, with emphasis on the use of tables and the solution of triangles.

(*g*) Theory and practice of simple surveying, including the use of transit and level, with taking of notes in proper form, based if possible on the student's own observations.

(*h*) Such problems in the machinist's, carpenter's and other trades as may be appropriate without special equipment, selecting local practical problems as far as possible.

(*i*) Arithmetical and other problems relating to house-furnishing, dress-making, millinery, dietetics and household economics.

Courses (*a*) and (*c*) should be for boys and girls alike, although they may be abridged for the girls if desired. Courses (*b*), (*d*), (*e*), (*f*), (*g*) and (*h*) are for boys only, while (*i*) is for girls alone.

While many academic teachers may rebel at the suggestion of such courses as have been mentioned, honest thought and consideration for the real benefit to the pupil must convince him that such material as will help the boys or girls to gain that which will be of immediate and real value to him in his work is of more importance to the person who does not go to college than some of the usual forms of pure mathematics.

(B) The High, Trade, or Vocational School with Special Mechanical Equipment.

Pupils in these schools should be given little pure mathematics that is not of direct practical value, but the greatest possible amount of the kind which will be of real use to them in the office or shop.

Arithmetic should be reviewed until the pupil is able to handle common and decimal fractions, percentage and square root with speed and accuracy. Skill should be developed in mental calculations, estimating results, and short methods for addition, subtraction, multiplication and division. Arithmetic, algebra

and geometry should be blended as far as possible, although each subject should be recognized and taught as such.

The work in algebra should be based on the idea of teaching the pupil to solve ordinary equations, write, transform and apply formulas, and work with graphs as the principal end in view. The course should include algebraic expression, simple, simultaneous, and quadratic equations with problems, and the plotting of graphs for a variety of curves and equations.

The formal work in geometry should be cut down to a small number of essential theorems. A large number of problems in plane and solid mensuration should be given, until the pupil can find dimension, surface, or volume for any common geometrical form, or object formed by combination. This work should be correlated with the study of formulas under the head of algebra.

A course in trigonometry and logarithms is important, and should by no means be omitted. It may be comparatively brief, but should be sufficiently thorough to enable the pupil to solve triangles of all kinds, including applications to practical problems.

In connection with the above, instruction should be given in the use of the surveyor's level and transit, with taking of notes in proper form and solution of triangulation problems.

Considerable time should be devoted to the subjects of shop mathematics, mechanics and strength of materials. A thorough knowledge of very elementary mathematics is sufficient to bring nearly every ordinary practical problem within the capability of the average older schoolboy. The large majority of the shop and office problems are purely arithmetical, and the boy must learn that the ability to solve them depends not so much upon his knowledge of mathematics as upon the exercise of logical reasoning. This course, or group of courses, is of great importance from the practical standpoint, and should include proportions of screw threads and gears with a variety of problems in machine-shop, carpentry and other lines of trade work, as well as problems in materials subjected to tension, compression, and shear, bending moments, investigation and design of simple beams and columns, graphical and analytical determination of stresses in simple framed structures, and design of members. Work of this kind can be amplified almost

beyond measure, according to the local conditions and demands. The pupil should by all means use and become familiar with one or more of the standard machinist's or structural handbooks and learn to read tables of all kinds and interpolate between values in order that his work in the school may be related as far as possible to the real operations of shop and office.

Possibly a word in behalf of the slide rule may be appropriate at this point. The time has long since gone by when this instrument was looked upon as a curiosity for the mathematical shark, a new-fangled notion of no practical use. Today an engineer who does not approve of the use of the slide rule is not abreast of the times. The pupil should learn to use it with accuracy for the ordinary computations, and realize its limitations as well as its possibilities.

The work indicated above is of course intended especially for boys. For girls, mathematics is too often looked upon as an unimportant and abhorred subject,—an evil inflicted upon them by an unsympathetic teacher or inflexible system. This is truly a most unfortunate illusion for the pupil, and too often a traditional sidestepping on the part of the more or less unconcerned teacher. Girls for whom the high is the finishing school should unquestionably be given a carefully planned arithmetical course, reviewing the common operations used in ordinary calculations, followed by courses in simple algebra and mensuration. After these should be offered a wide variety of problems in domestic science, household economics, housefurnishing, dietetics, dressmaking and millinery. There have been published one or two excellent books bearing on these topics, and if carefully taught by a thoughtful teacher the girls will see a value in and take a real interest in the much hated subject of mathematics.

The above paragraphs apply particularly to schools which are nearly or entirely non-college preparatory. For those institutions which offer both preparatory and non-college preparatory work it may not be possible to make the entire course in mathematics distinctive for each group. In this case if it be a four-year course, the first two years may be devoted to elementary algebra and geometry for both alike, after which as much as possible of the work outlined above may be given to the non-college preparatory group.

(C) The Commercial High School.

Judging from observations it would appear that for a large proportion of our commercial courses work in mathematics is to a considerable degree looked upon as unnecessary or unimportant. The truth is that for no class of pupil is a working knowledge of arithmetic more important than for the commercial. Ought the commercial graduate to be an automatic manipulator of typewriter and ledger, or should he be able to apply his knowledge and ingenuity to whatever common-sensible problems occur in the course of a week's work? The person who graduates from a commercial school has as great a likelihood of becoming a general office or shop assistant as he has of becoming a stenographer or bookkeeper, and for him a thorough knowledge of elementary mathematics is well-nigh indispensable.

For commercial students, the following general outline is suggested.

Ninth Year: Business Arithmetic (Required).—(*a*) Review of addition, subtraction, multiplication, and division of whole numbers, with emphasis on the importance of pupils learning the habit of checking results.

(*b*) Thorough drill in common and decimal fractions and aliquot parts.

(*c*) Percentage, with special applications to the reckoning of gain or loss on both the cost and the selling price.

(*d*) Commercial (or trade) discount.

(*e*) Simple interest; thorough drill, with special stress on the sixty day method.

(*f*) Bank discount.

(*g*) Simple formulas; numerical substitution and the solution of equations in one unknown.

(*h*) Simple graphs as applied to examples arising in business.

Tenth Year: Business Mathematics (Required).—(*a*) Review of topics (*a*) to (*f*) of ninth year.

(*b*) Accurate (or exact) interest.

(*c*) Compound interest.

(*d*) Taxes and fire insurance.

(*e*) Life insurance (studied briefly).

(*f*) Stocks and bonds (studied briefly).

(*g*) Domestic and foreign exchange.

(*h*) Plane and solid mensuration with no formal geometrical proofs. Review (*g*) of ninth year introducing formula work wherever possible.

(*i*) Practical measurements in flooring, roofing, paving, capacity, lumber, etc.

(*j*) Commercial graphs, more difficult than in ninth year.

(*k*) Practical use of logarithms.

Eleventh or Twelfth Year: Advanced Business Arithmetic and Commercial Algebra (Elective for Either Eleventh or Twelfth Year).—(*a*) At least two months work in commercial algebra.

(*b*) Mensuration continued with a few formal proofs in plane geometry.

(*c*) Logarithms, with thorough drill in their theory and practice.

(*d*) Use of the slide rule.

(*e*) Series.

(*f*) Compound interest.

(*g*) Equation of payments.

(*h*) Annuities.

(*i*) Amortization.

(*j*) Depreciation.

(*k*) Bond valuation.

(*l*) Life insurance.

While the foregoing paragraphs are more or less general in character they are the result of serious deliberation on the part of the committee which presents them. Beyond question the special work in mathematics for our non-college preparatory pupils is sadly in need of strengthening, and it is earnestly hoped that the suggestions which have been offered may interest and encourage our teachers to attempt constructive work along this line wherever further development is needed.

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